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Beyond The Classroom: Linking TVET Educators' Knowledge and Skills for Industry 4.0 Readiness

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Abstract

The integration of modern technologies such as artificial intelligence and the Internet of Things (IoT) is causing a significant transformation in the education sector during the Industrial Revolution 4.0 (IR 4.0). Education is increasingly focused on fostering digital literacy and creativity to equip students with the necessary abilities to confront future issues. However, educators in Malaysia continue to encounter difficulties in comprehending and implementing the principles of Industrial Revolution 4.0 within their instructional environment. The primary impediment to instructors properly incorporating technology in teaching and learning is the absence of exposure and training opportunities specifically focused on technology 4.0. Thus, this study aimed to determine the proficiency of Technical and Vocational Education and Training (TVET) educators in terms of their knowledge and skills throughout the era of IR 4.0. This study included a total of 135 participants from three TVET institution in the state of Johor, Malaysia. The study utilised a quantitative methodology to collect conclusive and unambiguous evidence for statistical analysis through the use of a questionnaire. The study's findings indicate that most of the TVET educators possess a high level of preparedness in terms of knowledge (M=4.05) and skills (M=4.13) throughout the era of IR 4.0. The findings indicate a significant correlation between the proficiency of TVET teachers in the context of the IR 4.0, with a correlation coefficient of 0.46 ($p < .001$). This suggests that as these teachers become more proficient, IR 4.0 technologies are more successfully integrated into educational processes. Well-equipped educators are crucial in educating pupils for a digitally advanced workforce. Policymakers and educational institutions should invest in technical and vocational teacher professional development programmes to improve their skills and stay current with technology, creating a more effective and future-ready educational system.

1. Introduction

The Industry 4.0 Revolution commenced in 2016 with the advent of several cutting-edge technologies, including as automation, big data analysis, simulation, system integration, robots, cloud computing, and the Internet of Things (IoT). The revolution presents novel obstacles and prospects for all industries in the nation, compelling

them to adjust and uphold their competitiveness while expediting advancement on the worldwide stage. As stated by Schwab (2015), the advent of Industry 4.0 has the capacity to revolutionize both our work practices and our way of life. The advent of the Fourth Industrial Revolution (IR 4.0) has led to significant changes across multiple domains, facilitated by several pivotal aspects that enable us to engage in work, communication, and resource management. The dynamic world is progressing towards the IR 4.0, which poses novel challenges to all sectors in Malaysia. IR 4.0 refers to a collection of fast advancing and merging technological advancements in areas like as artificial intelligence, virtual or augmented reality, automation, robots, Big Data, and the Internet of Things (IoT). The term IR4.0 encapsulates the comprehensive progress resulting from digitalization.

The Industrial Revolution, namely its fourth phase driven by digital technology, has led to various significant consequences, such as the acceleration of innovation, the restructuring of corporate frameworks, and large transformations in the labor market. Automation and artificial intelligence application improves manufacturing efficiency and revolutionizes labor procedures. On the other hand, topics like economic inequality and changes in traditional employment become extremely important issues. The field of national education is currently seeing a surge in response to the demands of 21st century education and IR 4.0. The 21st century is commonly linked to the age of information technology (IT), whereas Industrial Revolution 4.0 primarily pertains to the advancement of cyber physical systems, the internet of things, and cloud computing (Zervoudi, 2020). The recent advancements in open sky technologies undeniably have global ramifications for human existence. Education is the fundamental instrument for fostering the growth of human capital, which in turn contributes to the advancement of the nation. Diverse initiatives are undertaken to ensure the preservation of the nation's higher education. Internationalizing universities is a strategic endeavor aimed at elevating Malaysia's universities to a global standard. In order to ascertain the prerequisites for exemplary human traits, educators must enhance crucial elements within the instructional procedure. These include educational content, the psychology of learning, moral values, and identity.

The advent of the latest revolution will provide a certain degree of difficulty for educators as they will need to make adjustments in the execution of course objectives while also addressing the present requirements of IR 4.0. When considering this revolution, the focus is strongly placed on the utilization of robotics and automation technology. The revolution in industry has had significant effects on education, particularly in higher learning institutions. These technologies can only be operated by qualified individuals who possess advanced skills and knowledge. In Malaysia, a country heavily reliant on commerce to improve efficiency and achieve excellence, the use of technology is crucial for boosting global competitiveness and positioning the country as a leading manufacturing hub known for its outstanding quality (Ling, Hamid & Te Chuan, 2020).

Corporations are being compelled to adopt automation and data interchange in their manufacturing operations due to the onset of the IR 4.0. This has led to the emergence of intelligent factories that are connected to the internet and equipped with systems that offer a comprehensive view of the entire production process. The Industrial Revolution enabled the progress of education (Tsekeris, 2019), leading to increased efficiency, urbanization, and the widespread establishment of factories as the main centers of production. Education must align with emerging instructional methodologies in tandem with the swift advancement of technology. Technology has become deeply ingrained in society, permeating both the workplace and our daily routines. There are many who argue that the abilities we acquire via formal schooling are no longer applicable to the future. When discussing IR 4.0, terms like robotics, artificial intelligence (AI), innovation, and disruptive technologies are frequently mentioned. The incorporation of AI in education enhances students' comprehension of concepts. Viberg et al. (2020) asserted that Technical and Vocational Education and Training (TVET) instructors have challenges in digital literacy and lack preparedness to incorporate the principles of the IR 4.0 into their instructional sessions.

Teaching and learning today requires a focus on the creative and innovative parts. In addition, the teaching and learning approach needs to focus on students who collaborate and depend on one other. Active learning, project-based learning, problem solving and inquiry with opportunities to engage with the actual world need to be practiced. With the advent of open information sources and internet content, educators are no longer the main source of information (Szymkowiak et al., 2021). Having this information readily available enables Educators and students to swiftly and effortlessly retrieve knowledge. This implies that instructors are still necessary, but their function has shifted from being mere providers of information to becoming facilitators and consultants. Student-centered learning fosters the development of self-reliant students. In order to confront the advancements of IR 4.0 technology, individuals must possess proficiency, exhibit critical thinking abilities, demonstrate creativity, and excel in problem-solving.

Learning in the era of IR 4.0 enables individuals to enhance their skills to the fullest extent. Lecturers now have a broader role and responsibilities as they are not just teaching, but also taking on the major job of curating the essential knowledge for their pupils. Heggart & Yoo (2018) found that instructors have limited familiarity with IR 4.0 knowledge, despite its increasing prevalence in contemporary society. They are also perceived as a cohort lacking familiarity with the boundaries of technical advancement and contemporary industry practices. Enhancing the expertise and competencies of technical instructors in the industry is necessary to enhance the

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proficiency of technical graduates (Amin & Mustaqim, 2021). Training and education for the teaching staff at TVET schools is crucial due to the necessity of adapting to rapid technological advancements.

Teaching staff in the education sector should embrace modernization in order to avoid being limited to traditional lecturing methods or focusing primarily on lecturers. Utilizing unengaging methods, strategies, approaches, and techniques in teaching can result in a decline in the effectiveness of the teaching and learning process, ultimately leading to a fall in student performance (Hadinugrahaningsih, Rahmawati & Ridwan, 2017). Resolving this issue necessitates cooperation among the government, educational institutions, and industry to guarantee that TVET educators receive sufficient assistance to confront obstacles and equip students for success in a rapidly changing work environment. An imperative requirement for fostering competent workforce aligned with the ongoing educational change in the era of Industrial Revolution 4.0 is the implementation of a contemporary curriculum that incorporates modern technology.

The implementation of changes by all nations is crucial in order to realign vocational education with contemporary demands. Online education and instruction have emerged as a crucial element of the IR 4.0. The evolution of connectivity, digital platforms, and communication technologies has revolutionized the delivery and reception of education. A study conducted by Martin, Budhrani & Wang (2019) reveals that numerous educators in higher education have difficulties when it comes to utilizing online learning and teaching. Educators lack proficiency in utilizing digital technology to meet the requirements of online learning and instruction. As a consequence, the teacher's instruction is disrupted. Furthermore, in the age of the IR 4.0, it is crucial for instructors to possess digital literacy in order to enhance the quality of teaching and learning. The absence of comprehensive training programs and a comprehensive approach in fostering skills and knowledge related to the Industrial Revolution 4.0 could result in inadequate teacher preparedness.

Teacher knowledge is the outcome of acquiring and mastering knowledge during the process of learning. Four fundamental components of essential information that hold significance for an educator are subject knowledge, pedagogical expertise, general knowledge, and summary knowledge (Omar, Zahar & Rashid, 2020). Educators in technical subjects must possess expertise in technology to effectively instruct students in the practical use of industry-related technology. Proficient educators must possess extensive expertise in their respective fields and possess a comprehensive understanding of how to effectively utilise this information in the instructional and educational process. For Educators tasked with preparing competent workers for the IR 4.0, possessing understanding of technology is crucial. This expertise enables Educators to effectively use technology into their teaching and learning methods.

Educators must possess technological proficiency in order to serve as leaders of educational transformation (Hero, 2020). This enables them to enhance their learning experience by utilising pertinent technological tools. Proficiency in the realm of technology empowers educators to ignite imaginative and groundbreaking cognition in the execution of their duties. Hence, possessing a comprehensive comprehension and expertise in knowledge, together with proficiency in technology, is a crucial component in fulfilling the responsibilities of a teacher. The acquisition of information and abilities is crucial in developing competent instructors who can effectively address the current educational demands.

Proficiency in teaching is a crucial element in fulfilling the responsibilities of an educator. A teacher in the technical field must possess certain essential abilities. According to Lo (2021), the proficiency of Educators in areas such as topic knowledge, pedagogical skills, general knowledge, and specialised knowledge is crucial for becoming a high-quality educator. Proficient educators must possess extensive expertise in their respective fields and demonstrate adeptness in effectively applying it during the teaching and learning process. Educators, as agents of change, must possess technological proficiency. Proficiency in technology is crucial inside the technical domain. Educators must possess a high level of competence in utilising appropriate technological tools and software, and effectively incorporate these technologies into their instructional practices and student learning experiences (Yin, Han & Perron, 2020). Proficiency in pedagogical abilities is essential, since educators must possess a comprehensive understanding of impactful teaching methodologies, suitable learning approaches, and the ability to leverage technology to enhance students' educational encounters.

Generally, a conceptual framework is proposed and used as a guideline to achieve the research objectives of the study. The study utilises the teacher's knowledge model and the teacher's competency model as points of reference. The teacher knowledge model proposed by Alamri & Alasmari (2021) serves as a comprehensive framework to assist educators in comprehending and effectively handling key facets of their profession. These aspects encompass concepts, principles, and integration. The teacher competency model proposed by Laabidi & Nfissi (2016) highlights three crucial dimensions: technical proficiency, pedagogical expertise, and collaborative abilities. By acquiring proficiency in these talents, educators will be capable of fulfilling the requirements and expectations in the realm of education, guaranteeing a significant and applicable learning encounter for students. Figure 1 shows the conceptual framework of the study that has been designed to show the overall concept of this study to be conducted.

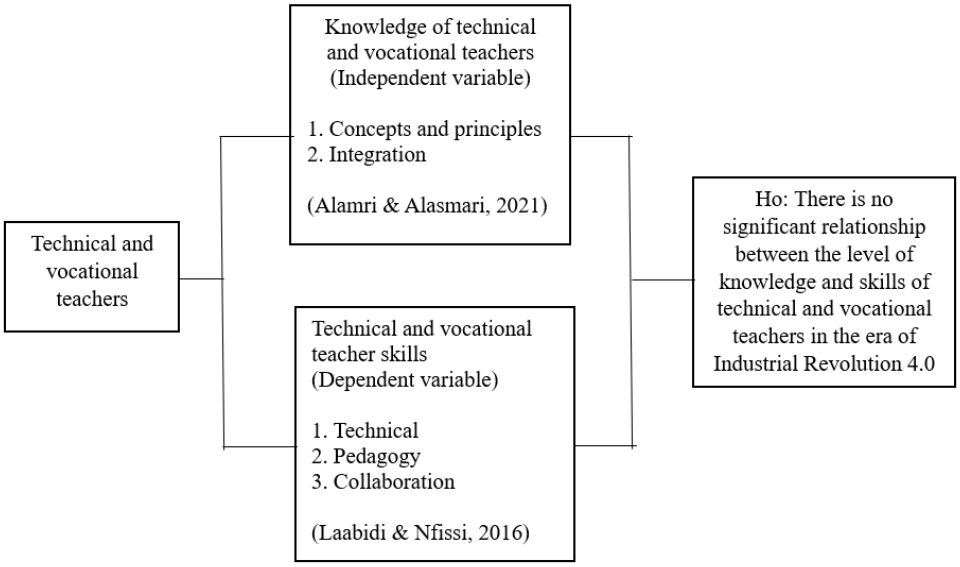

Fig. 1 *Conceptual framework of this study*

The study's conceptual framework, depicted in figure 1, is employed to elucidate the correlation between the two primary variables in this research. The knowledge of TVET educator which is technical and vocational teachers is the independent variable in this conceptual framework, while the skills of technical and vocational teachers are the dependent variable. Technical and vocational teachers' expertise pertains to their proficiency in subjects pertaining to their respective fields. This entails comprehending the most recent theories, concepts, methods, and practices in technical and vocational domains. The knowledge in question is considered an independent variable as it remains unaffected by other variables within the scope of this study.

The conceptual framework of this study considers technical and vocational teaching skills as dependent variables. Teacher abilities encompass their proficiency in effectively applying their knowledge in real-life scenarios and in the act of instructing. These encompass pragmatic abilities, interpersonal abilities, pedagogical abilities, and other abilities pertaining to technical and occupational domains. The talents of these teachers are shaped by their knowledge as well as other elements including experience, training, and professional assistance. The study's conceptual framework demonstrates that there is a correlation between the independent variable, teacher knowledge, and the dependent variable, teacher skills. Specifically, the study finds that teachers' knowledge in technical and vocational fields directly impacts their ability to effectively carry out their teaching duties and responsibilities. The expertise acquired by instructors in technical and vocational domains significantly impacts their teaching abilities and the proficiency of their students in those fields. The conceptual framework of this study serves as a visual tool that depicts the link between the variables and assists the researcher in conducting data analysis and interpretation.

2. Methodology

Carvalho (2024) defines a research design as a systematic strategy for gathering, quantifying, and scrutinising data in accordance with research inquiries. Furthermore, the research design incorporates several logical decision choices and should be presented in a manner that is comprehensible. A study plan is a systematic framework that facilitates the connection between research inquiries and the practical implementation or execution of research. To accomplish the mentioned objectives, the researcher must gather results and information regarding teachers' knowledge in technical and vocational fields directly impacts their ability to effectively carry out their teaching duties and responsibilities.

The study employed a quantitative methodology to gather decisive and definitive evidence for statistical analysis (Pandey & Pandey, 2021). The study objectives were achieved by employing a survey design as the data gathering strategy in this research. The researcher employed random sampling as the chosen technique for this study. Random sampling utilises randomization, ensuring that every individual in the population has an equal opportunity to be included in the selected sample (Lavrakas et al., 2019). A study sample including 135 teachers was recruited for this investigation. The deliberate selection of three vocational colleges, specifically Vocational College A, Vocational College B, and Vocational College C, was made. The questionnaire serves as the primary means of gathering data in this study due to its suitability in addressing research questions and achieving research objectives. It is particularly advantageous as it is standardised and can be interpreted uniformly by all respondents (Mazhar et al., 2021).

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2.1 Research Procedure

The initial phase entails commencing the investigation by choosing a subject, subsequently followed by formulating a problem statement. The issue statement entails the identification of the research problem, as well as the establishment of the research objectives and research questions. Next, a systematic literature review is undertaken to acquire relevant literature sources that serve as reference sources for the study. In the second phase, the focus is on identifying the problematic areas and then formulating and improving the questionnaire queries. This is done prior to doing the validity assessment and pilot testing of the instrument. The instrument's validity necessitates evaluation by three experts in the relevant subject prior to being conducted as a pilot study. Pilot research is conducted to assess the reliability and efficacy of a study, ensuring its suitability for the real implementation. Ultimately, the third stage entails gathering data through the implementation of the designated research framework. Evaluation will be conducted using visual depictions, data tables, and test outcomes to ascertain the acceptance or rejection of the hypotheses proposed in the study.

2.2 Research Instrument

The research approach used in this study involves the application of a survey method by administering a questionnaire. The questionnaire items were extracted from many sources, in accordance with the study's goals and to tackle the research inquiries. However, the evaluation of validity and reliability is still conducted in order to ascertain the appropriateness of instruments for the study. A questionnaire is a commonly utilized data collection tool in case studies by academics. Utilizing a questionnaire offers the advantage of facilitating regular, thorough, and structured data collection. The experts were chosen to evaluate the research instrument's validity according to their competence and knowledge in the relevant sector. Language specialists were selected to review the grammar and sentence structure of the questionnaire. The language specialist was selected for their over 20 years of expertise as a Malay language instructor. Hence, the specialists are chosen according to the specified criteria. Researchers can enhance the quality and reliability of their study by adhering to these guidelines, ensuring confidence in the instruments and data collected. The pilot study took place at one of the TVET institutions outside Johor. Questionnaires were given to 30 teachers prior to distributing them to the study participants. This pilot study, comprising 30 instructors, aims to establish an initial framework for understanding TVET teachers' perspectives on their readiness for Industrial Revolution 4.0.

This preliminary study is crucial as it enables the researcher to refine the study instrument, enhance validity and reliability, and resolve any issues that may occur prior to conducting the main study. By following this step, researchers can guarantee that the research process works efficiently and the data collected is of superior quality. The preliminary study's findings showed that the reliability index varied from 0.95 to 0.97, indicating an adequate level of reliability. The reliability scores for knowledge and abilities indicate Cronbach's Alpha values of 0.97 and 0.95, which are considered acceptable. This study demonstrates that survey items can be included in the questionnaire without the necessity of excluding any items. The questionnaire covers the two main aspects of teacher expertise: knowledge and abilities.

Table 1 *Contents of the questionnaire instrument*

Sections	Item	Number of Items
Part (1)	Teacher Readiness Level in terms of Knowledge	9
Part (2)	Teacher Readiness Level in terms of Skills	10

Participants were requested to indicate their level of agreement using the five-point Likert scale presented in Table 2. Croasmun & Ostrom (2011) states that the Likert scale is employed for assessing the attitudes, views, and perceptions of individuals or groups about social issues. The items were modelled following Thurstone's approach, which enables respondents to select one choice from a list (Böckenholt, 2017).

Table 2 *Likert scale agreement*

Score	Indicator
1	Strongly disagree
2	Disagree
3	Slightly agree
4	Agree
5	Strongly agree

Based on Table 2, the participants will evaluate the assertions of each item using a 5-point scale that spans from 1 (indicating strong disagreement) to 5 (indicating strong agreement). The analysis of the data collected from Part (1) to Part (2) involves the computation of descriptive statistics, including the mean, standard deviation, frequency, and percentage. The findings were displayed in tabular and graphical formats. An analysis was performed on the data from both Part (1) and (2) about the level of teacher ready in terms of knowledge and abilities. The analysis employed the utilization of frequencies and percentages. An analysis was performed on the data collected from the original five-point Likert scale in both Part (1) and (2) to determine the level of teacher preparedness in terms of knowledge and abilities during the era of Industrial Revolution 4.0. The investigation sought to determine whether these traits were classified as low, medium, or high. The researchers chose the mean of the data set as the most accurate metric to represent the data set. The analysis of the average scores is displayed in Table 3.

Table 3 *Mean score interpretation*

Interpretation Range	Mean Score
Low	1.00-2.33
Moderate	2.34-3.67
High	3.68 -5.00

Inferential statistics are employed to examine the comparability, correlation, and impact of variables. The Pearson correlation was employed to assess the inferential statistical analysis in order to investigate the potential association between the level of knowledge and skills of technical and vocational teachers in the era of Industrial Revolution 4.0. The Pearson correlation is a statistical test utilized to quantify the extent of the association between variables that are linearly related, assuming that the data follows a normal distribution (Shi & Conrad, 2009). The normality of the data was assessed using the skewness and kurtosis analysis test (Zulnaidi & Majid, 2020). Ahsanullah, Kibria & Shakil (2014) states that a data set is considered to be normally distributed if its skewness and kurtosis values are within the range of -1.96 to +1.96 or are close to zero. According to Azzalini (2013), a fully normal distribution would exhibit zero skewness. Data normalcy can also be ascertained through the utilization of histogram plots. If the graph exhibits a bell-shaped curve and the two-tailed significance value is more than 0.05 ($p>0.05$), then the data is considered to be normally distributed.

This study assumes that the variables will follow a normal distribution. As a result, the Pearson correlation test, which is a parametric test, will be used. However, if the variables do not follow a normal distribution, the non-parametric Spearman correlation coefficient will be used instead (Corder & Foreman, 2014). In order to examine the association between the variables in the parametric test, the hypothesis was evaluated by measuring the correlation coefficient, denoted as r, which ranges from -1 to 1. If the values of r are around 0, it indicates the absence of a (linear) connection or link. If the readings are close to ± 1, it indicates a highly significant correlation, with $r \geq 0.5$ being acceptable. The correlation coefficient value, r, is interpreted in Table 4.

Table 4 *The interpretation of correlation coefficient value*

Correlation coefficient value, r	Strength of linear relationship
≥ 0.8	Very strong
0.5 < r <0.8	Moderately strong
0.3 < r <0.5	Fair
< 0.3	Poor

3. Results

The acquired data has undergone a thorough analysis to ascertain the feasibility of achieving the study's objectives. Furthermore, the research findings are presented utilising measures such as frequency, percentage, and mean. The discussion of the study outcomes is divided into three primary sections. The initial section of the study delves into demographics by doing a thorough examination of the characteristics and attributes of the participants included in the research. The subsequent section focuses on the descriptive analysis of the variables examined in the study, specifically knowledge and abilities. The third portion of the paper focuses on the inference analysis, which particularly examines the link between the variables in the study, namely knowledge and abilities. This study included a sample of 135 technical and vocational teachers from Vocational College A, Vocational College B, and Vocational College C in Johor, Malaysia. Table 5 displays the frequency distribution of teachers categorized by gender.

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Table 5 *Frequency distribution and percentage of male and female teachers*

Gender	Frequency (*f*)	Percentage (%)
Male	70	51.9
Female	65	48.1
Total	135	100

The descriptive analysis of the level of preparation of technical and vocational teachers in terms of knowledge (K) during the Industrial Revolution 4.0 reveals that the mean value for each item (K1 to K9) falls within the range of 3.96 to 4.10. The maximum mean value is observed at K1 and K9, both reaching 4.10, however the minimum mean value is found at K3, with a value of 3.96. Furthermore, the standard deviation measured for each item indicates the degree of data consistency, with values varying between 0.49 and 0.67. The study indicates that the teacher's level of preparedness in terms of knowledge is generally high, with minimal variation observed across the evaluated items. A mean result that approaches or exceeds 4.00 suggests a favorable measurement in terms of the teacher's preparedness for the relevant information. Thus, it can be inferred that the teachers in this study demonstrated a satisfactory degree of preparedness in terms of their expertise. Table 6 displays the average value, measured by standard deviation and interpretation of teacher preparedness in relation to their knowledge.

Table 6 *Calculation of mean and standard deviation for teacher readiness level in terms of knowledge*

Item	The Level of Teacher Readiness From the Aspect of Knowledge	Mean	Standard Deviation	Interpretation
K1	I understand very well the meaning of Industrial Revolution 4.0 in general.	4.10	0.53	High
K2	I always follow the latest developments about the Industrial Revolution 4.0.	4.00	0.65	High
K3	I was able to explain the theories related to Industrial Revolution 4.0 in my teaching.	3.96	0.67	High
K4	I have technical knowledge about Industrial Revolution 4.0 through scholarly search from the internet.	4.04	0.62	High
K5	I was able to explain the use of Industrial Revolution 4.0 technology in the teaching I conducted.	4.07	0.61	High
K6	I am able to connect teaching and learning needs with Industrial Revolution 4.0.	4.04	0.53	High
K7	I am directly involved in teaching and learning that goes hand in hand with Industrial Revolution 4.0.	4.07	0.55	High
K8	I can relate the learning situation in the workshop to the real situation that happens in the industry.	4.08	0.49	High
K9	I can distinguish the technology used between Industrial Revolution 4.0 and Industrial Revolution 3.0.	4.10	0.54	High
	Average	**4.05**	**0.58**	**High**

According to the findings of the descriptive analysis on the skill component (S) of technical and vocational teachers' preparation, it can be inferred that the average value for each item (S1 to S10) falls between 4.01 and 4.21. The maximum average value was attained at S9, measuring 4.21, and the minimum average value was observed at S4, measuring 4.01. The standard deviation for each item exhibits a pretty consistent range of data variance, with values ranging from 0.49 to 0.71. This investigation determined that the teacher's proficiency in terms of skills is generally at a positive level. The teachers in this study demonstrated a high degree of proficiency in the evaluated setting, with a mean value over 4.00, particularly in S9. The minimal variability in standard deviation suggests a high level of consistency in instructor responses to each skill item. Thus, it can be inferred that the teachers in this study have a significant degree of readiness in the specific abilities under examination. Table 7 displays the average value average value, measured by standard deviation and interpretation, of teacher preparedness levels in terms of their skill aspect.

Table 7 *Calculation of mean and standard deviation for teacher readiness level in terms of skills*

Item	The Level of Teacher Readiness From the Aspect of Skills	Mean	Standard Deviation	Interpretation
S1	I have skills in applying Industrial Revolution 4.0 in class.	4.11	0.49	High
S2	I have skills in handling the use of Industrial Revolution 4.0 technology to launch teaching and learning.	4.16	0.50	High
S3	I have the skills to use educational applications via mobile phone to deliver my lessons to students such as Telegram and Google Classroom.	4.12	0.52	High
S4	I am able to apply QR Codes on workshop equipment for the subjects taught.	4.01	0.71	High
S5	I have the skills to upload learning materials in Data Cloud such as Google Drive.	4.04	0.60	High
S6	I have the skills to motivate students to enjoy learning related to Industrial Revolution 4.0.	4.14	0.53	High
S7	I have skills in relating the Industrial Revolution 4.0 in my teaching.	4.16	0.58	High
S8	I can deliver lessons in a way that suits the needs of the Industrial Revolution 4.0 and effective learning.	4.14	0.53	High
S9	I can help other teaching staff in the use of high-tech equipment and machines in line with the Industrial Revolution 4.0.	4.21	0.55	High
S10	I always share my skills with other teachers about the Industrial Revolution 4.0.	4.20	0.54	High
	Average	**4.13**	**0.56**	**High**

Inferential analysis is employed to address the third research inquiry, which is "Does a correlation exist between the proficiency and expertise of technical and vocational educators in the era of the IR 4.0?" The correlation test is an inferential analysis approach utilised to ascertain the magnitude and direction of the association between two variables, namely knowledge and abilities. The researcher employed a correlation test to assess the association between teacher knowledge and skills in this study. Prior to performing the correlation analysis, a normality test was undertaken to verify that the data followed a normal distribution. This technique ensures that the fundamental assumptions of the correlation test have been satisfied. Researchers can employ a correlation test to examine and quantify the degree of association between these two variables.

The normality test is a crucial step in evaluating the degree to which the analysed data adheres to a normal distribution. Skewness is a statistical measure used to evaluate the asymmetry of a data distribution, indicating whether the distribution tends to be positively or negatively skewed. A positive Skewness number implies a favourably skewed graph, while a negative value suggests a negatively skewed network. Kurtosis provides insight into the degree of peakiness or flatness of the data distribution. A positive kurtosis value signifies a high degree of curvature (leptokurtic), whereas negative values suggest a lower, flatter, and wider curvature (platykurtic). The skewness and kurtosis values fall within the permissible range, with a skewness value less than 3 and a kurtosis value less than 10 (Corder & Foreman, 2014). The data collected in this study is deemed to be normal according to the normality test. The Skewness and Kurtosis values for each variable are displayed in Table 8.

Table 8 *Skewness and kurtosis values in the normality test*

Variable	Skewness	Kurtosis
Teacher Readiness Level in terms of Knowledge	1.28	2.11
Teacher Readiness Level in terms of Skills	0.92	0.44

A correlation analysis was performed to determine the existence of a connection between the proficiency of teachers and their level of expertise. The variables in this study have a normal distribution and there is no major

violation of the assumption of linearity. According to the data in Table 9, Pearson correlation statistics were computed, with a correlation coefficient of r (135) = 0.46 and a significance level of p < 0.01. The Pearson correlation data indicates a connection between knowledge and skills. The teacher's level of skills increases in direct proportion to their level of knowledge. The relationship is positive, indicating that a greater amount of knowledge is associated with a higher level of skill.

Table 9 *Mean, standard deviation and intercorrelation for teacher knowledge and skills (N=135)*

Variable	Knowledge	Skills	Mean	Standard Deviation
Teacher Readiness Level in terms of Knowledge	1	0.46**	4.11	0.29
Teacher Readiness Level in terms of Skills	0.46**	1	4.17	0.29

P < 0.01

The positive relationship suggests that when the competence of these teachers improves, there is a commensurate beneficial effect on the successful incorporation of IR 4.0 technology into educational practices. This emphasizes the crucial importance of adequately qualified educators in preparing pupils for the requirements of a technologically enhanced labor market. Policymakers and educational institutions should priorities allocating resources towards professional development programmed for technical and vocational teachers. This investment will enhance their skills and ensure they stay up-to-date with technological advancements, ultimately leading to a more effective and future-ready educational system.

4. Discussion

Descriptive analysis can be used to determine the level of teacher preparedness for different knowledge components by applying the mean score of knowledge. The data reveals that the mean score is 4.05, calculated from the items that were responded to. This indicates that, on general, the teachers in this study have a considerable level of expertise regarding the IR 4.0. Emphasizing creativity and innovation should now be the primary goal of education. Additionally, the pedagogical approach should give priority to students who actively participate in collaborative and interdependent learning. Utilizing active learning, project-based learning, problem solving, and inquiry approaches is vital in order to afford students the opportunity to actively participate in real-world scenarios. The study was conducted by Fernández-Batanero et al. in 2022. As a result of the widespread availability of accessible information sources and online content, teachers are no longer the main providers of information.

The availability of this information allows teachers and students to quickly and easily access knowledge. According to Yurtseven Avci et al. (2020), instructors are still required, but their role has evolved from simply delivering material to now serving as facilitators and advisers. Education is no longer confined to the classroom but can now occur at home or any other place. The aforementioned challenges require modifications in the role of teachers as educators. Therefore, it is crucial for teacher training programs in various institutions to keep up with modern advancements and rapidly undergo updates in order to properly address this rising revolution. By familiarizing educators with the concept of Industrial Revolution 4.0 at an early level, they will have a more thorough comprehension of the changes and challenges that arise from advancements in industry and technology.

The result of the study corroborates with the research conducted by Susanti et al. (2020). The finding of the study indicates that educator's preparedness in terms of knowledge about the IR 4.0 ia at the high level. Teachers acknowledge that they must confront obstacles associated with IR 4.0, such as adjusting to online and blended learning. However, the limited internet connection inside the school environment hinders their ability to keep pace with understanding IR 4.0. Students have difficulties in comprehending and cultivating their capabilities, as well as confronting obstacles in problem-solving abilities, communicating, and establishing a worldwide network. Trainee instructors must also possess ICT capabilities, advanced cognitive abilities, teamwork proficiency, effective communication, and time management skills. These additional features are crucial for acquiring knowledge connected to the IR 4.0. The ever-evolving nature of technology is a problem that must be approached with caution. Teachers must also acquire the necessary knowledge and preparedness for the IR 4.0.

Additionally, the proficiency of educators confronting with the IR 4.0 in term of skills can be assessed by conducting a descriptive analysis based on the average skill scores. The result indicates that the average score for the teaching skills is 4.13, based on the item that been answered from the 10 items. Educators play a crucial role in addressing the challenges posed by the 4th industrial revolution in the field of education. They must be proactive in making necessary adjustments and demonstrate a high degree of inventiveness in line with the

latest technical advancements. Until now, it is undeniable that the proficiency and utilization of ICT among teaching personnel is still only at a moderate level. Therefore, educators can employ diverse strategies, such as enrolling in a specialized training program designed to enhance their proficiency in utilizing ICT, in order to align their skills with the requirements of the IR 4.0 era (Maknun et al., 2021).

Furthermore, in response to this progress, educators have the opportunity to employ innovative techniques in the educational delivery system, such as establishing a technologically advanced classroom. Teachers can utilize preexisting educational programs to facilitate learning and offer tasks to students using platforms like Quizziz, Kahoot, and similar alternatives. Even widely-used programs like TikTok, Twitter, and Facebook can serve as suitable platforms for task execution (Suharsono, 2020). Utilizing applications or technology not only enhances students' engagement in learning but also provides them with opportunities to enhance their proficiency in utilizing technology appropriately. An adaptable and engaging educational system should be extended, regardless of whether it is implemented in primary schools or higher education institutions, in order to enhance the appeal of learning.

The proficiency and expertise of technical and vocational instructors during the era of Industrial Revolution 4.0 significantly influence the current state of vocational education. The study findings indicate a correlation between the proficiency and expertise of teachers. The study's findings indicate a strong and positive association between these two factors. The Pearson Correlation coefficient of 0.46 indicates a direct relationship between the amount of teacher knowledge and their skill level, meaning that an increase in one corresponds to an increase in the other. This study posited a correlation between the proficiency and expertise of educators throughout the age of the IR 4.0. The justification is provided by citing Gerosa, Argentin & Spada, (2023), who asserts that there is a strong correlation between teacher knowledge and abilities, which play a crucial role in facilitating effective teaching. The expertise of teachers, particularly in the setting of the IR 4.0, is crucial for comprehending and proficiently navigating novel concepts, advanced technology, and industry advancements. However, information alone is insufficient without the requisite abilities to effectively apply it within the context of teaching and learning.

The results of this study align with the research conducted by Teo et al., (2021), that state a substantial correlation between knowledge components and abilities in connection to the preparedness of teacher for the IR 4.0. Putra et al.'s (2020) study findings indicate a direct correlation between teacher preparedness and their proficiency in using innovative teaching methods. Put simply, the preparation of instructors directly impacts their degree of knowledge and skills in innovative teaching. Hence, it is crucial to guarantee that educators are well equipped for online instruction and learning. Teachers who are able to adjust to this new standard can thrive in virtual instruction.

Furthermore, the research conducted by Rou, Rahman, and Surat (2022) demonstrates a direct correlation between teacher preparedness and proficiency in online teaching. The significant level of teacher preparedness for online instruction indicates a correspondingly high level of instructors' knowledge and expertise. Hence, it is crucial to guarantee that educators are well equipped for online instruction and learning. Teachers that can effectively adjust to this new standard can excel in virtual instruction, particularly in the period of the IR 4.0.

Consequently, it is imperative for the relevant parties to organize courses and workshops focused on online pedagogy for educators, enabling them to acquire expertise and proficiency in using online tools and techniques. Moreover, a user-friendly online teaching platform can be developed to facilitate teachers in quickly acquiring proficiency in its usage. The adaptation of teacher education training to incorporate technological knowledge and abilities must align with global advancements. Enhancements to infrastructure, particularly internet networks, are necessary to enable teachers and students to engage in teaching and learning activities without constraints of location or time. In light of the swift advancement of the worldwide economy and industry, educators are encouraged to acquire proficiency in information and communication technology (ICT) to effectively confront the issues posed by the I.R 4.0. In light of the swift advancement of technology in contemporary times, it is imperative for educators to possess a thorough comprehension of technology and be cognizant of its trajectory, in order to effectively facilitate the execution of a strategic plan.

5. Conclusion

The study revealed that the level of readiness among teachers in technical and vocational courses to confront the challenges of Industrial Revolution 4.0 requires significant attention. Teachers, particularly those in technical and vocational subjects, demonstrate their preparedness to confront the challenges posed by the IR 4.0 in the realm of education. Through the examination of knowledge and abilities, this study has demonstrated a clear and substantial correlation between these two criteria. The correlation results, albeit modest, are significant and highlight the importance of understanding the role of knowledge mastery in moulding and enhancing teaching skills. Enhanced knowledge is directly correlated with enhanced skills and vice versa, resulting in a comprehensive understanding of consistent and equitable requirements for professional growth. Within the realm of vocational and technical education, this result carries significant ramifications for the strategy and

approach of human resource development. Consistent endeavours to enhance the calibre of instructor expertise will bolster proficiencies that are pertinent to the present demands of the sector. The readiness of teachers is crucial in equipping students with the skills necessary to thrive in an ever-evolving professional landscape. This work offers a significant contribution to the existing literature in this particular sector. Hence, this conclusion serves as a stimulus for additional measures, such as enhancing ongoing educational opportunities for educators, repositioning the curriculum, and offering improved resources to shape the trajectory of vocational and technical education in the era of the IR. 4.0.

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